Coastal and Continental Shelf Processes in Ghana

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LONG-TERM GOALS

That the University of Ghana would become the Centre of Excellence in coastal processes research and training in the region. The Centre will provide leadership and sustain a network of coastal scientists who will guide formulation and implementation of science-based policies in their respective countries.

OBJECTIVES

The project is focused on building capacity in the University of Ghana to:

1. investigate processes governing coastline evolution in Ghana;
2. develop algorithms for the detection of fishing vessels and oil slicks; and
3. investigate meso-scale oceanographic phenomena in the Gulf of Guinea

APPROACH

The University of Ghana has acquired relevant field equipment to carry out investigations along the entire 550 km stretch of Ghana's coast. Ground control points (GCP) have been established along the coast to serve as reference points during field surveys. The framework of the collaborative research was designed in partnership with scientists from the United States and Europe, namely University of New Hampshire, United States Geological Survey, Woods Hole Oceanographic Institution, and UNESCO-IHE of Netherlands.

WORK COMPLETED

The activity completed during the fiscal year was a study on "Vulnerability and Risk Assessment of Ghana's Coast". This was based on computation of coastal vulnerability index (CVI) (Gornitz et al., 1991), a commonly used method to assess coastal vulnerability to sea level rise, in particular due to erosion and/or inundation. The index provides a simple numerical basis for ranking sections of coastline in terms of their potential for change that can be used by managers to identify regions where risks may be relatively high. The USGS used this formulation to evaluate the potential vulnerability of the U.S. coastline at the national scale (Thieler and Hammar-Klose, 1999). Data used in the computation of the CVI for Ghana were obtained from various sources: Coastal geomorphology was

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interpreted from 2005 orthophotos, taken at a scale of 1: 10 000. Geology was extracted from GIS Geological Map of Ghana at a scale of 1: 1 000 000, Coastal elevation was generated from 50-foot interval topographic data merged with bathymetric data. Shoreline rate of change were calculated using 1974 and 2005 high water mark proxy positions from aerial photos. The rates of change were calculated at 100 m intervals using the end point rate method in Digital Shoreline Analysis System. The rates were then averaged for each coastal district. Relative sea level rise has been estimated by the EPA as 2mm/yr and a global eustatic rate of 1.5mm/yr. Significant wave height has been reported as 1.2m. Average tidal range has been estimated as 1m. Risk factors were assigned to the various variables to produce vulnerability index map of coastal districts in Ghana (Table 1)

Table 1: Ranking of coastal vulnerability index variables for the Coast of Ghana

Variable	**Very low**	**Low**	**Moderate**	**High**	**Very high**
	1	2	3	4	5
Geomorphology	Rocky coasts	Medium cliffs	Low cliffs	Estuary, Lagoon	Deltas, Sand beaches, Mangroves
Coastal Geology	Pegmatite, biotite tonalite	Amphibolite, gneiss, quartzite	Limestone, sandstone, mudstone, conglomerate	-	Alluvial sand, silt, clay
Coastal Elevation	>30	>20 and <=30	>10 and <=20	>5 and <=10	>=0 and <=5
Relative sea-level rise(mm/yr)	<1.8	1.8-2.5	2.5-3.0	3.0-3.4	>3.4
Shoreline erosion/accretion (m/yr)	>2.0	1.0-2.0	-1.0-1.0	-2.0--1.0	<-2.0
Mean tide range(m)	>6.0	4.0-6.0	2.0-4.0	1.0-2.0	<1.0
Mean wave height(m)	<0.55	0.55-0.85	0.85-1.05	1.05-1.25	>1.25

Computation of coastal vulnerability index (CVI) was adapted to the coast of Ghana, necessitating the use of seven variables in the equation:

$$CVI = \sqrt[2]{\frac{x_1 . x_2 . x_3 . x_4 . x_5 . x_6 . x_7}{7}}$$

where x1 to x7 represent, respectively, geomorphology, coastal geology, coastal elevation, relative sea-level rise, shoreline erosion/accretion, tidal range and wave height.

RESULTS

The entire coast is dominated by erosion with rates ranging from between 1.43 m/year to 7.71 m/year. The western and eastern ends of Ghana's coast were noted as the most vulnerable locations to natural

events and processes, and together, constitute 36% of the 550 km shoreline (Figure 1). These areas cover the districts of Jomoro (in the west), Dangbe East, Sogakope, Keta and Ketu (in the east). These areas are generally very low lying sandy beaches with high energy waves. The region of low vulnerability is partly due to the presence of rocky beaches and lagoon inlets which reduce significantly, the landward advance of the coastline. Elevation along these sections are higher compared to the eastern and western sections. This assessment has provided an objective technique for evaluating long-term planning and hazard prevention and management along Ghana's coast.

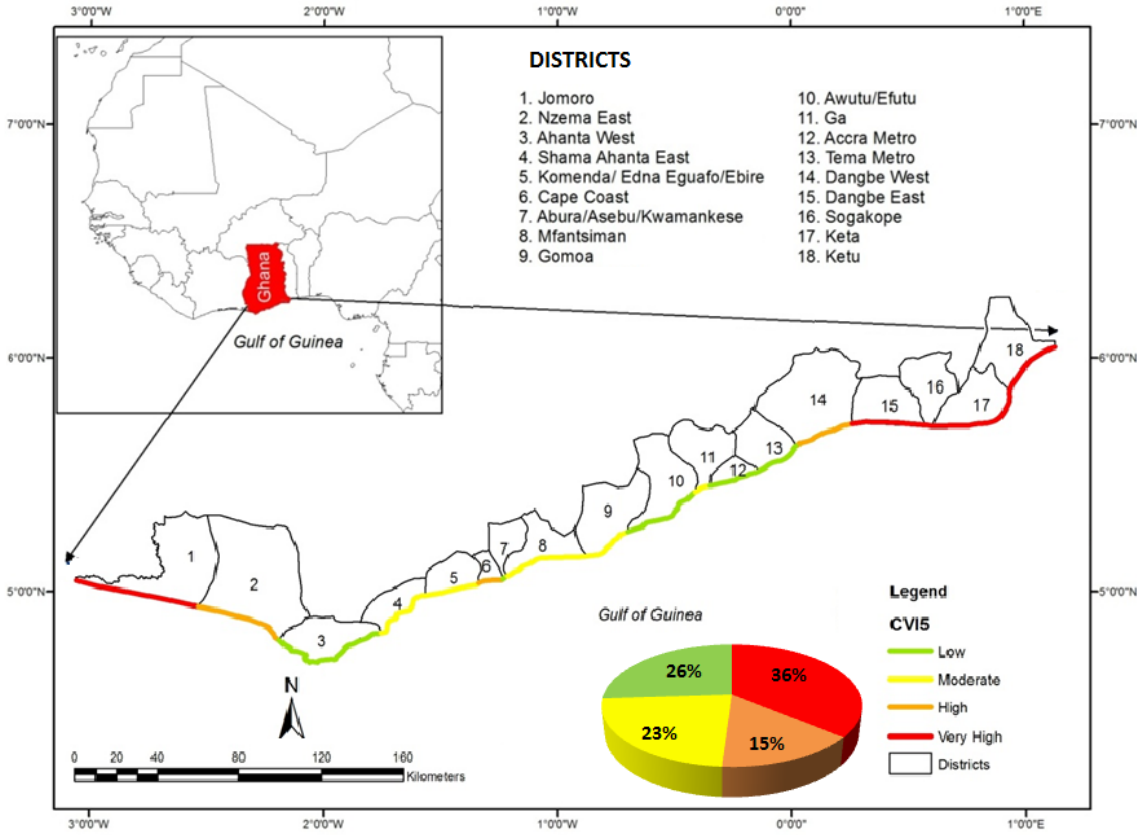

Figure 1. Coastal vulnerability map for Ghana based on CVI values calculated for each coastal administrative district.

IMPACT/APPLICATIONS

This study has provided a detailed assessment of vulnerability along the coast of Ghana. The information is relevant for effective planning and management of the coastal environment. Findings from the research were presented at a workshop to key stakeholders, including policy makers, coastal managers, researchers and practitioners. The research is having significant impact on academic related programs at the University of Ghana. Through a collaborative effort with our external partners, novel investigative approaches in coastal processes research are being developed. Government Ministries, Departments and Agencies are benefitting from the outcome of the research. This would be translated into development of pragmatic policies for sustainably management of the coastal area.

RELATED PROJECTS

Oil slick detection

Increasing vessel traffic and tanker operations after the discovery of oil in commercial quantities in deep waters off western Ghana has made it imperative for development of algorithms to aid in routine oil slick detection. Students at the University of Ghana are carrying out studies on application of synthetic aperture radar (SAR) in detecting oil slicks.

Vessel traffic monitoring

The Gulf of Guinea continuous to experience illegal, unregulated and unreported (IUU) fishing activities, illegal oil bunkering, piracy, trafficking of human and narcotic drugs among others. Limited capacity and poor monitoring and surveillance is contributing to the increase in these illicit activities. The University of Ghana continued its collaborative research with Space and Naval Warfare (SPAWAR) of the US Navy on use of synthetic aperture radar (SAR) in combination with automatic identification system (AIS) for vessel identification and detection in support maritime surveillance.

Identification of Potential Fishing Zones (PFZ)

The Department of Oceanographic and Fisheries, through the DevCocast/EAMNet initiative is receiving partially processed ocean colour and sea surface temperature data broadcast under the GEONETCast system. Commercially important fishes are known to aggregate along fronts which exhibit high biological production. The presence of fronts are being analyzed together with tuna catch data to understand thermal variability along fronts and its impact on tuna distribution. These datasets are being processed to generate ocean frontal maps to support fisheries management.

Capacity building in the University of Ghana

The Department of Oceanography and Fisheries have revised its curricular at the undergraduate and graduate levels to accommodate advances being made by the project in courses on satellite remote sensing and coastal processes.

Manual for coastal processes assessment and management in Ghana

The Project has established a Coastal Processes Research Group at the University of Ghana. The Research Group has produced a Manual on coastal processes assessment and management of Ghana's coast. The manual covers topics such as: Background information on Ghana's coast; Design of institutional framework for integrated coastal and marine environment; Shoreline Monitoring and modelling Techniques; Development of integrated shoreline management plan for Ghana, and case studies derived from some of the research. The manual is expected to be used by students, researchers, and coastal managers.

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